physical science no less than it was a canon of historical science that speculation should confine itself to construing past events by the analogy of those of the present time. The hypothesis of construction seemed to him unacceptable, because it led them into contravention of tradition on the one side and into contravention of scientific logic on the other. The only other alternative hypothesis was that of evolution, which meant that the different forms of animal life had not arisen independently of each other in the great sweep of past time, but that the one had proceeded from the other; and that that which had happened in the course of past ages had been analogous to that which took place daily and hourly in the case of the individual. That was to say that just as at the present day in the course of individual development the lower and simple forms, in virtue of the properties which were inherent in them, passed step by step by the establishment of small successive differences into the higher and more complicated forms, so, in the case of past ages, that which constituted the stock of the whole ancestry had advanced grade by grade and step by step until it had attained the degree of complexity which was seen at the present day. No objection could be brought against this hypothesis on the ground of analogy, because in putting it forward they were not bringing in any kind of causation which was not abundantly operative at the present time. The question was whether the history of the globe in past time coincided with this hypothesis, and to that point he would next address himself. What did they find if they considered the whole series of these forms? Unquestionably, as he had said, nautili were found as far back as the Upper Silurian age. Before that time there were no nautili, but there were shells of the *Orthoceratidæ*—of which there were magnificent examples before him—which resembled those of the nautili in that they were chambered, siphoned, &c., with the last chamber of such a size that it obviously sheltered the body of the animal. He thought no one could doubt that the creatures which fabricated these still earlier shells were substantially similar to the nautili, although their shells were straight, just as a nautilus shell would be if it were pulled out from a helix into a cone. Then came the forms known as the *cyrtoceras*, which were slightly curved. Along with these they had the other forms which were on the table, and in which the shell began to grow spiral. The next that came were forms of nautilus, which differed from the nautilus of to-day in that the *septa* were like watch-glasses, and that the whorls did not overlap one another. In the next series, belonging to the later palæozoic strata, the shell was closely coiled and the *septa* began to be a little wavy, and the whorls began to overlap one another. And this process was continued in later forms, down to that of the present day. Looking broadly at the main changes which the nautilus stock underwent, changes parallel with those which were followed by the individual nautilus in the course of its development, he considered that there could be no doubt that they were justified in the hypothesis that the causes at work were the same in both cases, and that the inherent faculty, or power, or whatever else it might be called, which determined the successive changes of the nautilus after it had been hatched, had been operative throughout the whole continuous series of existence of the genus from its earliest appearances in the later Silurian rocks up to the present day. What the whole question, in whatever way it might be put, came to, was this: Successive generations of animals were so many cycles of evolution that succeeded one another. Within the historical period, there was no doubt that, speaking roughly, those succeeding cycles had been identical, that was to say, without discernible difference. But when the period of observation became proportional to the slow rate of change they found, so to speak, that the hour hand had moved; for, in the successive cycles of evolution which had occupied the whole period, successive cycles had differed from one another to a slight extent. If they might assume that, then the whole of the phenomena of palæontology would fall into order and intelligibility. If not, they had to adopt an hypothesis which, as he had pointed out, had no support in tradition, and which was absolutely contradicted by every sound canon of scientific research. This was his case for evolution, which he rested wholly upon arguments of the kind he had adduced. From the time when he first read Charles Darwin's "Origin of Species," now some twenty-four years ago, his mind had fixed itself upon the tenth chapter of that book, which treated of the succession of forms in geological times, for it appeared to him that that was the key of the position; that if the doctrine of evolution was correct, the facts of palæontology, as soon as they became sufficiently known, must bear it out and verify it in every particular. On the other hand, he believed that, if the facts of palæontology or the historical facts of life on the globe were against evolution, then all the rest of the argumentation in its favour would be vain and empty, because the difficulty of adopting it would be in that case absolutely insuperable. He would venture to repeat that the occurrence of evolution was a question of history. He did not know whether Sir Henry Maine was not more competent to speak on that point than he was. It was a question as to whether they would interpret the facts of animated nature scientifically, or whether they would open the door to every description of hypothetical vagary. He came to the conclusion that that was a point worth testing in every possible way, and for some twenty years he had given what leisure he had been able to beg, borrow, or sometimes steal, to the investigation of these questions. He had endeavoured to ascertain for himself how the doctrine of evolution fitted with the facts of palæontology, with regard to the higher vertebrated animals, and with regard to the chief varieties of invertebrate animals, and all he could tell them was that the farther his own investigations had gone, the more complete had appeared to be the coincidence between the facts of palæontology and the requirements of the doctrine of evolution. The conclusion he had come to was that at which every competent person who had undertaken a similar inquiry had arrived, and if they would pay attention to the writings of such men as Gaudry, Rütimeyer, Marsh, Cope, and others, who had added materials upon which to form a judgment such as were not dreamt of when Darwin first wrote, they would find that they all without hesitation attached themselves to the doctrine of evolution as the only key to the enigma. In deciding the issue between the two hypotheses, serious inquirers would not trouble themselves about any collateral points as to the how and the why, or as to any of the subordinate points at issue. He thought he was entitled to entreat those who by their calling or by their position in society, or by the fact that they possessed any influence, might be led to express an opinion upon this matter, to look into the arguments which formed the foundation of the case for evolution. Happily, he might address that recommendation to members of the University of Cambridge with a perfectly good conscience, for at this present time he knew not where in the world any one could find better means of passing through all those preliminary studies which were essential to a comprehension of this great question, or where any one could find more amply displayed the means of testing the arguments which he had laid before them. He ventured to say that the members of this University were without excuse if they gave opinions on this question of evolution without having prepared themselves, by as diligent study as they would for the purpose of approaching questions of literary or theological criticism, to express an opinion upon it. These were the considerations which he had wished to set before them that day. It would be understood that they would not suffice to enable any one to form a judgment upon the doctrine of evolution, but he hoped that they had sufficed, brief and insufficient as they were, to show that if judgment on this question was to be worth anything intellectually, if it was to be creditable to the moral sense of those who formed it, it would first be necessary that the facts should be clearly comprehended, and that the conclusion—whatever it might be—should be one which right reason would admit might be justly and perfectly connected with the facts.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The term that has just concluded has been chiefly noticeable for the interest drawn towards Oriental studies in the University by the building of the new Indian Institute. The visit of the Prince of Wales to the Chancellor of the University served to draw national attention to the work which Oxford, and especially Balliol College, has undertaken in respect to the training of the selected candidates for the Indian Civil Service. In spite of the failure of the late attempt to induce the University to relax its rule requiring three years' residence as a qualification for a B.A. degree in the case of the Indian Civil Servants, a considerable proportion of the selected candidates come into residence at the University; Balliol, by providing teachers and tutors in Oriental subjects, attracts by far the greatest number.

With the exception of two debates there has been little excitement during the term in the Convocation House. The two questions that roused general interest were, first, the proposal that

examiners in the Pass Schools should allow merit in one subject to compensate for a deficiency in another; and secondly, the decree to grant 10,000*l*. to Prof. Burdon Sanderson for the equipment of the new Physiological Laboratories. In the first debate the proposal was only carried by the casting vote of the Vice-Chancellor, and some doubt has since been raised on the qualification of one of the voters. In the second debate the opponents of vivisection, allied with those who oppose any large expenditure by the University on economic grounds, sought to throw out the decree and force the University to make special provision against the Professor experimenting on living animals. Prof. Burdon Sanderson in his speech disclaimed any intention of introducing vivisection into his courses or demonstrations, but declared that he would experiment on living animals in his own researches if he deemed it necessary for the discovery of truth. The decree was carried in a large house by 88 votes to 85.

The Commemoration in the Sheldonian Theatre passed off with less uproar this year. Among the recipients of honorary degrees Lord Rayleigh and Sir Frederick Abel represented Science.

In November next Balliol and Christ Church will hold examinations for electing to Natural Science Scholarships. The subjects at both colleges will be Chemistry, Physics, and Biology, with an essay and an optional paper in Mathematics.

CAMBRIDGE.—The Senior Wrangler in the Mathematical Tripos (Parts I. and II.) is Mr. Mathews, of St. John's College; Mr. Gallop is second; Mr. Lachlan, third; Messrs. Chevallier and A. N. Whitehead, bracketed fourth—all of Trinity College. One lady, Miss Perrin, of Girton, is placed between the 20th and 21st Wranglers. Three ladies are senior optimes; one is junior optime.

The Special Board for Mathematics have recommended that the Smith's Prize be awarded for the best essay on any subject in Mathematics or Natural Philosophy, to be sent in about a year and a half after the candidates are of standing for Parts I. and II. of the Mathematical Tripos; and that the adjudicators be the Vice-Chancellor, the Mathematical Professors, and the Cavendish Professor.

Prof. Foster has given notice of a revision class in Physiology during the Long Vacation, to be held at the Physiolog cal Laboratory.

The proposed regulations for the Balfour Fund have been formally adopted by the senate.

The annual report of the Observatory states that, owing to the great progress made with the zone observations it has been possible to give much attention to the comets of recent years, and important contributions to the computations of their orbits have been made by the Observatory.

The General Board of Studies have published their recommendations with regard to new teachers, buildings, and appliances, and it is at once evident that several times the whole amount of the new income of the University could readily be spent in supplying the distinct wants of the several departments. They confine their recommendations as to Readerships within narrow limits owing to the extreme pressure upon University Funds, but they recommend the appointment of the present Readers in Indian Law, Classical Archæology, and Talmudic Literature as University Readers at 300*l*., not 400*l*. as proposed by the Statutes, a Reader in Comparative Philology at 300*l*. and a Reader in Botany at 100*l*. a year, tenable with a College Lectureship. As to University Lecturers, that is College Lecturers who throw open some of their lectures to the University and give advanced lectures, they recommend, as regards Medicine, four University Lecturers; Mathematics, five; Biology—one in Botany, one in Zoology; three in Physiology; two at least in Geology; and others in other departments.

More Demonstrators, the senior to be better paid than at present, are further recommended to be appointed in various departments of Natural Sciences.

The appointment of a Professor of Pathology is again pressed as urgent; provision to be made for a temporary laboratory.

As to buildings, the Board have placed among urgent requirements the extension of the buildings for Physiology and Comparative Anatomy, Chemistry, Botany, Mechanism, and for Geology, to be partly supplied by the Sedgwick Memorial Fund. As extra to the latter fund, 10,000*l*. is asked.

A special grant of 500*l*. for physiological apparatus is recommended. Further, the Museum and Lecture Rooms require at least 350*l*. more annually from the new funds, in addition to 500*l*. asked for from the ordinary income of the chest.

The cost of a chemical laboratory is provisionally estimated at 15,000*l*., and the purchase of Prof. Stuart's plant, with which he has at his own risk developed the flourishing school of engineering in the University, at 2,500*l*. Then permanent buildings for the school of Mechanism would cost 3,500*l*. more.

The recommendations of the General Board, after sifting and reducing the recommendations of the Special Boards, will entail annual charges of 4,360*l*., in addition to at least 2,500*l*. required by new professorships or new elections to existing professorships.

Capital expenditure will be required for buildings 31,200*l*., and for special grants other than building, 4,810*l*.; but it is proposed to borrow for these purposes. The Board have been informed that the special sum (500*l*.) asked for physiological apparatus will be provided by the liberality of a private donor who wishes to remain anonymous.

No voting can take place on these proposals till next term.

The special reports, on which the detailed Report of the General Board of Studies is founded, contain much interesting information about the present state of Natural Science studies in the University.

The Medical Board ask for provision for teaching in Medical Jurisprudence, Sanitary Science, Mental Diseases, and Elementary Medical and Surgical Methods. The number of students at present is about 200.

The report of the Classical Board contains an elaborate account of the present provision for studying Philology, Antiquities, Ancient Art, Topography, &c. which we cannot here reproduce.

The Board of Oriental Studies ask for University Lectures in Hebrew and Sanskrit, and for a Reader in Syriac, and that the Lord Almoner's Professor of Arabic be secured, if possible, as a resident professor by the augmentation of his stipend. They also urge the importance of establishing teaching in the departments of Egyptology and Assyriology.

The Mathematical Board estimate the resident students for Mathematical Honours as between 300 and 400. There are thirty-four College Lecturers in Mathematics, much of whose time is occupied in preparing candidates for the pass examinations. It will be impossible to secure adequate teaching of the subjects of Part III. of the Mathematical Tripos unless at least University Lecturers are appointed, and the Board ask for five at 50*l*. a year, two courses of advanced lectures being required from each lecturer every year.

The Board for Physics and Chemistry in addition to the laboratory claims press for additional means of catechetical teaching in Chemistry and instruction in Technical Electricity; in Mechanism a Superintendent of the Workshops, and in Mineralogy a Curator of the Museum. The number of students in Chemistry in the University is nearly 200; in Physics (Cavendish laboratory only), average for last two years, 54; Mechanism 42; Mineralogy 9.

The Board urge the advisability of Colleges permitting their lecturers in Chemistry and Physics to lecture in the University lecture rooms and laboratories, to allow more efficient organisation of teaching, as well as economy in expenses.

Lord Rayleigh asked for 600*l*. additional for Demonstrators in Physics, but the General Board of Studies have only recommended 220*l*. to be granted.

Professor Stuart's workshop has not more than half supported itself by fees of students as yet, but by employing the workmen in the manufacture of apparatus, &c., for other University departments after their hours of teaching, he has made a profit sufficient to pay the deficit, except the cost of demonstrators. A superintendent of the workshops is absolutely necessary if the University keeps up the school of Engineering, and a demonstrator in each department. Thus the Professor would not as now, be required to teach in the workshops and act as general manager as well as demonstrator. A considerably larger foundry is required, as the department has proved most useful.

The Board for Biology and Geology recommend the appointment of a Professor of Animal Morphology, and, failing this, three University Lecturers in this subject, one of whom shall direct the laboratory.

In relation to Physiology, Dr. Foster made an elaborate report, describing the organisation of, and work done in, his laboratory. He asked for a head demonstrator and four assistant demonstrators. As to advanced lectures, mention was made of the very largely unpaid work undertaken by Dr. Gaskell (entirely

unpaid), and Messrs. Langley and Lea, and University recognition of their work was asked for. Elementary Biology and Physiology of the Senses were also mentioned as needing a special lecturer.

With regard to Botany, teaching in Vegetable Morphology and in Physiology is urgently required, with lecture rooms and laboratories.

It is further asked that University teachers be eventually appointed in Agriculture, Anthropology, Geography, Metallurgy, and Mining.

In Geology it is pointed out that since Prof. Bonney left Cambridge, no College has given any assistance towards geological teaching, and that Dr. Roberts and the other demonstrators have received no University or College payments for the continued work they have done in lecturing and demonstrating.

The average number of students at present in the various departments of Biology and Geology is—Botany, 80; Geology, 40; Zoology, 75; Physiology, 120; Human Anatomy, 100 each term.

Donald MacAlister, M.D., M.B., Fellow and Medical Lecturer of St. John's College, Cambridge, was on Thursday, June 14, elected a member of the Council of the College.

The following awards have been made at St. John's College for proficiency in Natural Science:—Foundation Scholarships to Andrews, Kerr, Phillips (R.W.); Exhibitions to Goodman (already Scholar), Cooke, (E. H.), Fenton, Jones (H. R.), Watts; a Proper Sizarship to Gepp. Goodman obtains a Wright's Prize with augmentation of emoluments to 100*l*., and a Hughes' Prize, as one of the two most distinguished third-year students in the College. The Open Exhibition was awarded to Rogers.

Mr. J. V. Jones, Principal of Firth College, Sheffield, has been elected by the Council to be the first Principal of the University College for South Wales and Monmouthshire.

SOCIETIES AND ACADEMIES

London

Royal Society, May 24.—"The Effects of Temperature on the Electromotive Force and Resistance of Batteries, II." By **William Henry Preece, F.R.S.**

In the discussion on the previous paper read on February 22, 1883, it was suggested that observations should be made on the influence of temperature to the case of secondary batteries. One of Mr. Tribe's cells was used.

The negative element of this cell consisted of pure peroxide of lead in the form of a plate 4 inches square carried in a grooved frame, from one end of which projected the necessary conductor. This element was placed between two plates of finely divided lead likewise 4 inches square. These were joined together, and formed the positive element of the cell. Each half of the positive plate was about a quarter of an inch distant from the negative, and all three plates were incased in a thin specially prepared fabric. The elements were contained in a leaden case, and the liquid was sulphuric acid of the strengths given in the various experiments. This cell was placed inside the cylindrical copper vessel used in the previous experiments, and precisely the same method of observation was adopted. The influence of heat on secondary cells was the same in kind as in the Daniell cell, but it differs very much in degree. The electromotive force practically remains constant for all degrees of temperature, but the internal resistance diminishes as the temperature increases at a very steady rate, increasing again as the temperature is lowered. The effect of varying the percentage of acid in solution is not very marked, though as might have been anticipated from Kohlrausch's observations, the 30 per cent. proportion gives the lowest resistance. The mean average reduction in resistance between 0° and 100° C., is 59·6 per cent.

Chemical Society, June 7.—Dr. Perkin, president, in the chair.—The following papers were read:—Laboratory notes by J. H. Gladstone and A. Tribe: (1) On the action of light and heat on cane and invert sugars; cane sugar solution, when heated, forms a small quantity of a substance which is not alcohol, but which gives the iodoform reaction. (2) On hydroxylamine; the copper zinc couple reduces this substance, ammonia being formed. (3) On the recovery of iodine from organic iodide residues; the residues are poured on to an excess of the couple, and the iodide of zinc formed, extracted with hot water; iodine is obtained in the free state by the action of hydrochloric acid and bleaching powder on the iodide. (4) A residual phenomenon of the electrolysis of oil of vitriol; the formation of Berthelot's persulphuric acid was noted. (5) On an alleged test for alcohol; Davy suggests that alcohol can be detected by the blue colour produced with a warm solution of molybdic anhydrid in oil of vitriol. The authors find that other reducing substances and sugar give the same reaction. (6) Reaction of the couple on nitric oxide; ammonia is formed, but no protoxide. (7) On the reducing action of spongy lead.—Note on a basic ammonio-copper sulphate, by S. U. Pickering.—Notes on Loew and Bokorny's researches on the probable aldehydic nature of albumin, by A. B. Griffiths.—Note on the action of sulphuric acid, sp. gr. 1·84, upon potassium iodide, by H. Jackson. The author has investigated this reaction quantitatively; he finds that two reactions occur, one with an excess of sulphuric acid when iodine and sulphur dioxide are formed; the second when just sufficient sulphuric acid is used to satisfy the potassium iodide; iodine and sulphuretted hydrogen are then liberated.—The action of nitrous anhydride on glycerin, by O. Masson. The author obtained the trinitrite of glyceryl; it is an amber-coloured liquid boiling at 150°, burns with a white flame, but does not explode under the hammer. It is decomposed by water, and cannot be preserved. In sealed tubes it generates sufficient gas to shatter the glass.

Linnean Society, June 7.—Sir John Lubbock, Bart., president, in the chair.—Mr. R. J. Clarke and Mr. Frank Matthews were elected Fellows of the Society.—Mr. W. T. Thiselton Dyer exhibited a series of Copals: some from Inhambane, near Mozambique, the product of *Copaifera Gorskiana* of various sorts, with a melting point from 310° to 360° Fahr.; others from Lagos (obtained by Capt. Moloney), used by the natives for burning, and powdered by the women as a body perfume. These last are supposed to be from a species of *Daniellia*, the native name being "Ogea."—Mr. Hiern drew attention to specimens of *Quercus Ilex*, var. *Fordii*, from Barnstaple, Devon, showing remarkable alteration in the leaves after pruning. There was exhibited for Mr. Stansfield R. Rake a burdock leaf with numerous excrescences, supposed to be the result of insect irritation.—Mr. G. Murray exhibited specimens of dace killed by the fungus disease (*Saprolegnia ferax*), the result of inoculation, and said to be the first recorded experimental proof of the communicability of the disease to those fish.—Dr. Cobbold showed shrimps sent by Dr. Burge of Shanghai. They contained immature flukes, which it was thought might prove to be the larval state of one or other of the three species of human fluke known to infest man in eastern countries. He proposed to call the parasite *Cercaria Burgei*.—A paper was read by Mr. H. N. Ridley, on new and rare monocotyledonous plants from Madagascar, among which may be mentioned species of *Drimia* hitherto only known from Africa, several curious orchids, one remarkable for possessing only one or two very large, handsome green, white, and purple flowers. Of Cyperaceæ one form well known as an Indian plant, another of the genus *Fintelmannia*, supposed to be confined to Brazil; he also describes a new genus, *Acriulus*, allied in some respects to *Cryptangium*.—A communication was read from Mr. George Lewis, on Japan Brenthidæ and notes of their habits. These beetles form part of the collection made by the author in his visit to Japan during the summers of 1880-81. He observes that there is no geographical barrier sufficient to exclude tropical forms from Japan, but their environment, when they reach it, prevents them from establishing themselves, to any great extent at least, in the northern parts. In the southern islands of the Japanese Archipelago the warmer climate enables a fair number of beetles of a truly tropical type to exist. The fact that each genus is only represented by one species nevertheless points to some physical check in their spread and numbers. A new genus, *Higonius*, is characterised, and several species of this and other genera described and illustrated.—Mr. T. H. Corry read a paper on the fertilisation of the Asclepiads, chiefly bearing out views noticed on a former occasion.—A short record of observations on the White Ants (Termites) of Rangoon, by Dr. Robert Romanis, was read by the Secretary. He details what he saw in what may be termed the swarming of a nest.

Edinburgh

Royal Society, June 4.—Mr. Thomas Gray, vice-president, in the chair.—Mr. Buchan read a second paper on the oscilla-